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# Prevention of Hypertension: A critical review of the Health benefits of Salt, Garlic, Fish Oil, Chocolate and Vitamin D

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**ABSTRACT**
**Background**: Hypertension could be defined as a blood pressure measurement of 140/90 mmHg or above obtained by ambulatory blood pressure monitoring. It is a global pandemic affecting about a billion people and causing 9.4 million deaths worldwide with its associated complications. Hypertension has no clear symptoms and therefore is also called the silent killer. With these debilitating effects, prevention of hypertension has become necessary.
**Aim:** The purpose of this literature review was to discuss how salt, garlic, fish oil, dark chocolate and vitamin D could prevent hypertension.
**Method:** An extensive review of literature was initiated by accessing the following search engines: Cochrane library, Medline and CINAHL. Articles gathered ranged from year 2005 to 2014. Thirty-eight (38) articles were obtained for the discussion.
**Conclusion:** Reduced salt, garlic, fish oil, chocolate and vitamin D could prevent hypertension from happening. This study observes that these foods have the ability to effect changes in the vascular smooth muscle cells that could aid in the prevention of hypertension.

## INTRODUCTION

Hypertension could be defined as a blood pressure measurement of 140/90 mmHg or above obtained at the clinic and by ambulatory blood pressure monitoring [1]. It is the blood pressure level where advantages of treatment far more outweigh the disadvantages and thus the use of medication is inevitable [2]. There are 3 stages of describing hypertension according to [1]: stage 1 (140/90mmHg and above); stage 2 (160/100 and above) and severe (180/110 and above). Hypertension is also called the silent killer as it has no clinical manifestations in its early stages [3]. It can only be detected by checking the blood pressure using sphygmomanometer [2]. There are 2 types: essential (primary) and non-essential hypertension [4]. Studies reveal that about 90-95% of diagnosed hypertension are essential hypertension while the remaining 5-10% are non-essential hypertension [5]. Where the essential hypertension has no cause thus idiopathic, non-essential hypertension might have underlying causes such as renal diseases, hyperthyroidism, phaeochromocytoma, Cushion's syndrome and many more [5].

The prevalence of hypertension is also highly documented. Beevers et al. [6] reports that about one billion people worldwide are affected by the disease, a figure corroborated by latter studies by the WHO [3]. But Shouk et al. [4] predicts that the number could rise to approximately 1.6 billion adults by the year 2025. According to WHO [3], the disease is a global epidemic affecting both the developed and developing nations. But it is reported to be highest in the low and middle income countries of the world. Hypertension also causes about 9.4 million deaths worldwide of which 45% and 51% are due to heart disease and stroke respectively [3]. In the UK, about 30% of the population is suggested to be having a raised blood pressure, the NHS choices [7] reports. The treatment of hypertension with the use of medications alone cost about a billion pounds in the year 2006 alone [8]. Hypertension when left untreated could lead to target organ damage (TOD) which causes complications such as cardiovascular diseases, cerebrovascular accident (stroke), kidney failure, death and many more [2]. Lifestyle modification has been identified as one of the effective ways of preventing this disease [3, 7]. Such lifestyles could cut across diet, exercise, minimal alcohol intake, smoking cessation, weight reduction etc. With the high numbers in its prevalence, it is prudent that much effort be put into preventing its occurrence as the adage goes, 'prevention is better than cure.'

The author chose to do this extended review on hypertension prevention because there seem to be

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several medical complications arising from hypertension even though there seem to be much awareness. Hypertension has caused the sudden death of supposedly healthy young people who had died overnight only for a post mortem to reveal cerebral haemorrhage or infarction, a complication of the disease. Such occurrences had led to several presentations by the author on the disease to raise awareness in his church.

Hypertension prevention is a broad theme which encompasses lifestyle modifications such as diet, exercise, smoking cessation, reduction in alcohol intake, weight loss, stress management as well as pharmacological interventions [2]. All of the above interventions are heralded to be effective in preventing or reducing high blood pressure and more effective when they are used in combination. But for the purpose of this literature review, an in depth study would be taken to analyse how certain foods could affect the blood pressure when they are included or reduced in our daily diet.

**PURPOSE STATEMENT**

To present an extended literature review on how salt, garlic, fish oil, dark chocolate, and vitamin D could prevent hypertension. The literature review is presented as follows: the search strategy, critiquing of five quantitative researches under the above mentioned foods and the discussion of their findings in context with other literature, recommendations and conclusion.

**SEARCH STRATEGY**

The search engine used NORA which gives access into other search engines such as the Cochrane library, Medline and CINAHL was obtained. The words diet and hypertension prevention were used in the initial stages of the search. The time range was set between 2005 and 2014. Further searches with the words 'salt and hypertension prevention', 'chocolate and hypertension prevention', 'fish oil and hypertension prevention', garlic and hypertension prevention' and then 'vitamin D and hypertension prevention' were used. Primary quantitative researches, specifically randomised control trials (RCT), were selected for each theme for the appraisal of the research process. The author chose quantitative researches for critiquing because he wanted to obtain reports which suggested the effectiveness of each of the foods selected in the prevention of hypertension [9].

**SALT**

The effect of salt in the development of hypertension has been highly documented. Salt is a chemical combination of sodium ($Na^+$) and chloride ($Cl^-$). For every gram of salt, there is a 0.4g of sodium. However, salt and sodium could be used mutually to refer to the same thing [10]. Studies reveal that about 70 per cent (%) of the average sodium intake are obtained from processed foods which are so commonly available [10, 11]. Again, Patience [10] adds that other sources of salt occur naturally in plants and animal foods constituting about 15-20% of sodium intake. Shaldon and Vienken [14] argue that with the advancements in knowledge about the positive effects of low salt consumption, the developed nations in the world still consume more salt. This in part could be attributed to several causes with manufactured foods taking centre stage of our daily food intake.

In their research, He et al. [12] observed that a moderate reduction (9.7 to 6.5 g/day) in salt intake caused a significant reduction in blood pressure of all of their hypertensive subjects from 3 different ethnic groups: namely Blacks, Whites and Asians. They observed decrease from an average 146 to 141mm Hg systolic blood pressure and from 91 to 88mm Hg for diastolic blood pressure. This study was done in participants with essential hypertension. Such important reductions have also been observed by other studies including [8, 13, 14]. Some evidences reveal that salt reduction alone could reduce blood pressure in patients with secondary hypertension even when the underlying causes are not treated [8, 11, 14]. In their literature review, Shaldon and Vienken [14] suggest that sodium reduction also caused a significant blood pressure reduction in dialysis patients. They further claimed that a strict adherence to salt restrictions could cause significant reductions in such patients that they might not need antihypertensive medications. Again, Kumanyika et al. [8] observed in their review of the Trials of Hypertension Prevention Phase II (TOHP II), a reduction in blood pressure after a moderate reduction in salt in overweight participants. They also suggest that some of the reductions in the blood pressure were independent of weight loss among the participants. This effect was also observed in the study conducted by Appel et al [11].

Other investigations into dietary salt reveal that low sodium diet alone could be as effective as Dietary Approach to Stop Hypertension (DASH) diet in obtaining a significant reduction in the blood pressure [10]. This observation was made when DASH diet was

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used in the control group with the intervention group taking in salt at different amounts labelled as high, intermediate and low. The low salt diet was observed to perform equally well in reducing blood pressure when it was compared to DASH diet which was also observed to reduce blood pressure at different ranges of salt [10]. She postulated the ranges of sodium as high (above or equal to 3.3g/day), intermediate (above or equal to 2.4g/day) and low (below or equal to 1.5g/day). This outcome could also suggest that the significance of blood pressure reduction is directly proportional to the severity of sodium reduction. This suggestion is supported by other evidences [11, 15, 16]. However, Saptharishi et al. [16] caution that there are other studies that did not observe this effect.

Patience [10] and Appel et al. [11] report that the effect of low dietary salt in reducing blood pressure is more significant in hypertensive participants than in normotensive people. Appel et al. [11] observed in their systematic review that there was an average of 2.0/1.0 mmHg BP reduction in normotensives as compared to 5.0/2.7 mmHg BP reduction observed in hypertensive patients. He et al. [12] observed a 5/3 mmHg reduction in BP after a moderate salt reduction from 9.7g per day to 6.5 g per day in 3 ethnic groups (Blacks, Whites and Asians). However, blacks are reported to stand a high risk of becoming hypertensive than the other ethnic groups [11, 17]. The others are thus classified as salt resistant. It is reported that blacks are more sensitive to salt that people of the other ethnic groups thus they are more prone to have salt sensitive hypertension. Other risk factors that enhance salt sensitivity may include age, chronic kidney disease, diabetes and hypertension [2, 11]. However, Appel et al. [11] observed that a reduction in dietary salt intake caused significant blood pressure reductions in both salt sensitive and resistant groups.

A high dietary salt intake has been observed to increase the endothelial production of transforming growth factor-beta (TGF-B) [14, 15, 17]. Studies in rats reveal that TGF-B causes endothelial stiffness and deformability by depositing collagen in both large and small arteries, glomeruli, the heart and kidneys [17]. Sodium in its high proportions have also been identified to increase asymmetric dimethylarginine (ADMA) which reduce nitric oxide (NO) production in the arteries by inhibiting nitric oxide synthase (NOS) thus increasing oxidative stress. Increased salt also enhances the activities of angiotensin II in the vascular cells which has been known to enhance oxidative stress to cause hyperplasia and hypertrophy of vascular smooth cells [14, 15]. Houston [15] postulates that with these changes in vascular cells, the ability of endothelial vasodilation could be suppressed after 30 days.

In summary, low salt intake has been observed to have hypotensive effects especially in hypertensive patients. It has also been found to cause little reductions in normotensive individuals. Though some people are thought to be more at risk because of their genetic make-up and ethnic group, low sodium intake has been identified in this review to have reductive effect on blood pressure. The mechanism of action by which salt intake could cause hypertension has also been analysed in this review. Thus it could be said that the reverse of this mechanism by the reduction of dietary salt intake could prevent the development of hypertension in the normotensive person.

**GARLIC**

Garlic and its extracts are argued to be one of the most widely used unconventional antihypertensive treatment by people with hypertension [18]. In their study, over 50 per cent of their respondents admitted using it either alone as antihypertensive therapy or in combination with the orthodox medicine. Studies reveal that garlic contains over 100 volatile and non-volatile sulphur containing compounds which have been observed to have medicinal values of which hypertension is included [4]. Some of these bioactive components of garlic have been identified as allicin, S-allylcysteine (SAC), saponins, ajoene, flavonoids, phenolics, etc. and majority of them have been identified to reduce blood pressure in diverse ways [4].

Reid et al. [19] in their RCT report of the BP reduction ability of garlic in participants with treated but uncontrolled hypertension. Garlic or its extracts have been suggested to be effective in reducing systolic BP among treated but uncontrolled hypertension patients [15]. But this effect could be argued to have been caused in part by the conventional treatment the participants were taking. This arises because there are evidence that reveal that garlic could interact with other conventional treatments for high blood pressure. Captopril, for instance, has been identified to interact well with garlic to produce a significant antihypertensive effect according to [4, 20]. However, Houston [4] suggests a reduction in BP as observed in his review of other researches. He observed that garlic was effective in reducing the BP in hypertensive participants by 8.4/7.3 mm Hg. Again, Reid et al. [19] observed a reduction in

BP among the participants with systolic BP less than 140 mm Hg but this was an insignificant reduction.

The effect of garlic has been suggested to be dependent on the amount used. Houston [15] suggests that to obtain a substantial BP lowering effect, 4 cloves of garlic (5g) would be required. This amount would produce approximately 10000mcg of allicin [15]. Reid et al [21] gave 960mg of aged garlic extract with a 2.4mg of SAC to his participants over a period of 12 weeks to obtain the effect in that study. Again, Houston [15] postulates that the type of garlic preparation used could also have an effect on the efficacy and potency.

The mechanism of action by which garlic is understood to produce hypotensive effects have been documented in several ways. This in part is due to the numerous bioactive components that it possesses. However, evidences reveal that it enhances production of antioxidants in the blood vessels causing vasodilation. These antioxidant effects have been observed to be exhibited by majority of the bioactivity components embedded in garlic. This would then prevent oxidative stress in the vascular cells and prevent vasoconstriction that would cause hypertension [4]. SAC has been identified to trap reactive oxygen species (ROS); allicin is suggested to rid the cells of free radicals and inhibit nicotinamide adenine dinucleotide phosphate (NADPH) oxidase, a catalyst for ROS; saponins are recognised to enhance cell viability; ajoene has also been identified to scavenge hydroxyl radicals; and phenolics also induces endogenous defense. All of these activities by these bioactivity components of garlic have been observed to reduce oxidative stress leading to reduced blood pressure [4].

Again, garlic is suggested to reduce BP by blocking angiotensin converting enzyme (ACE) from converting angiotensin I to angiotensin II [4, 15]. Evidence has it that garlic and it components could further nullify the certain activities of angiotensin II [4, 18]. In their study, Castro et al. [18] report that garlic components could prevent angiotensin II from producing ROS and causing hypertrophy and hyperplasia of the vascular smooth muscle cells.

In summary, the benefits of garlic in the reduction of hypertension have been outlined and the mechanism of action in the cells has also been explored. From the above analysis, it could be argued that garlic could play a significant role in the prevention of hypertension. Therefore, it would be expedient to add garlic to the daily meal.

**FISH OIL**

Omega-3 polyunsaturated fatty acid (PUFA) is believed to be the active ingredient in fish oil, hence the names are used interchangeably to mean the same thing [20]. Major sources of this food nutrient include fish oils, cold-water fishes like (herring, trout, tuna, haddock, salmon, cod and mackerel) and other sources like flax, flax seed, flax oil and some nuts [15]. Fish oil supplements are also good sources as it is most often used in the various studies to determine its effects [22]. Several evidences including [23, 24] have isolated the active ingredients in fish oil that affect blood pressure to include docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA).

In the study by Mori et al. [25], it was revealed that fish oil had reducing effect on blood pressure (BP). This result has been observed in other studies including [11, 15, 22, 23, 26]. However, this study was conducted in people with chronic kidney disease (CKD) indicating that participants were already having hypertension. Findings from the study however revealed a significant reduction in BP with a higher reduction in the sleeping BP values. These findings were also observed in other studies in hypertensive people using fish oil [22, 26]. In a meta-analysis of 17 RCTs on effects of omega-3 on BP by Campbell [22], 8 of them were performed on hypertensive participants and all observed a clinically important decrease in BP. Again, Ueshima et al. [26] in their study of 4680 hypertensives and normotensives from 4 different countries, also observed a decrease in BP in the people with hypertension. However, findings of the effect of omega-3 in normotensive people remain negligible. Some evidences reveal that the BP reduction effect of omega-3 is minimal though present in people with normotensives [22, 26]. In their meta-analysis, 9 RCTs in people with normal BP revealed an insignificant reduction in their blood pressure [22]. This outcome was also observed in the 2038 normotensive participants [26].

In their study, Mori et al. [25] used a fixed dose of omega-3 (4g) to observe the BP reduction effect of fish oil. However, there evidence which suggests that the reductive effect of omega-3 on BP could be dose related. This effect has been observed in some studies that the higher the dose, the higher the reductive effect on BP [11, 15, 26]. Appel et al. [11], however, suggest that dose equal to or above 3g might be required to obtain the

minimising effect on BP. But this notion, on the other hand, has been challenged by Campbell et al. [22]. They argue that a relatively lower dose of fish oil could have the same effect on the BP. In a systemic review, Houston [15] reveals that reductive effect of fish oil on BP could be observed when cold-water fish is eaten 3 times per week. The study adds that this could be equal to a high dose omega-3 supplement.

Evidence on the mechanism of action of the effect on BP is not clearly understood. However, Mori et al. [25] suggest that the process could involve 'suppression of vasoconstrictor prostanoids, release of nitric oxide (NO), reduction in plasma noradrenaline, changes in calcium flux and increased membrane fluidity. Thus in their research, the effect of fish oil on vascular compliance was assessed and observed to enhance large artery elasticity. This mechanism by which omega-3 could affect the BP was also acknowledged by Ueshima et al. [26]. However, an insight into how fish oil could affect BP [23, 24]. Grynberg [23] in his study reveals that both DHA and EPA could reduce BP by altering the membrane fluidity of vascular cells and influence the prostanoids balance which also influences vasodilation and vasoconstriction of arterial walls. In their study in laboratory mice, Hoshi et al. [24] discovered that DHA could play a specific role in the reduction of the BP by causing vasodilation. They observed that DHA had the ability to activate Slo1 BK channels in the vascular smooth muscles of blood vessels to cause vasodilation. On the other hand, the mechanism of EPA in the reduction of BP has been suggested to be unclear but it has been observed that it does not enter the cardiac membrane phospholipids [24].

In summary, the review of literature on the hypotensive effect of fish oil has revealed that fish oil could reduce BP. However, this effect was attenuated in researches that involved normotensive participants and rather visible among hypertensive participants. But it could be that with the same mechanism of action, fish oil could prevent a normotensive person from becoming hypertensive. Thus, it would be beneficial to include it in our daily diet as a means of preventing hypertension.

**CHOCOLATE**

Evidence of the health benefits of chocolate especially in its ability to significantly reduce blood pressure (BP) has been observed in many studies [15, 19, 27, 28,]. However, there are other evidence**s** like that of van den Bongaard et al. [29] that suggest that that ability might have to be scrutinised as their studies did not reveal the same effects. Dark chocolate/cocoa has been observed to have in it flavanols and theobromine in high quantities [15, 27, 29, 30]. These two components of cocoa are thought to cause the antihypertensive effects (Ibid). However, flavanols especially have received much attention in various studies to ascertain its effects on BP. Though it is found in high amounts in dark chocolate, flavanol has also been found in fruits, red wine, licorice, soy and tea [15, 30]. But its occurrence in chocolate and its effect on BP is intriguing as other studies have revealed the weight gaining effect of chocolate ingestion [27].

In their study, van den Bongaard et al. [29] did not observe any significant decrease in 24 hour systolic BP in stage 1 hypertensive participants when they were given a flavanol-rich cocoa with natural dose of theobromine. On the contrary, they observed a rather increased 24 hour systolic BP in the participants who received a flavanol-rich cocoa with a high dose of theobromine. However, other studies show the reducible effect of cocoa on BP. Reid et al. [27] in a meta-analysis of 15 studies observed a significant reduction in both the systolic and the diastolic blood pressures after dark chocolate intervention. This outcome was also observed by an original study by Grassi et al. [31] and two other systematic reviews by Egan et al [28] and Desch et al. [32]. In their studies, Grassi et al. [31] observed a reduction in both daytime and night time blood pressures as they conducted a 24 hour ambulatory BP monitoring. But this outcome was not observed by van den Bongaard et al. [29] who also conducted the same monitoring. However, the differences in outcomes could be as a result of numerous factors including the differences in what was used for the control groups of each study or the brand of chocolate used in the intervention groups [28]. The latter would then raise the argument about the dose.

In their review of 13 researches, Egan et al. [28] observed from 4 of them that the higher the dose of chocolate, the more reduction in the BP. The first 3 studies gave 100g chocolate with 50 per cent cocoa to the intervention group for 14 to 15 days and had a result of 5 to 11 mmHg reduction in systolic BP. The other 1 gave a 6.3g of dark chocolate plus 3.1g cocoa daily for 18 weeks to observe a decline of 2.9 mmHg in systolic BP (Ibid). But Desch et al [27] reveal in their study that the difference in reduced blood pressure after giving 25g and 6g per day for 3 months was negligible and

rather the higher dose increased the weight of the participants.

Again, there have been diverse observations about the hypotensive effect of cocoa between normotensives and hypertensives. Some studies observed as significant reduction in BP in normotensive participants as in hypertensives Grassi et al [31]. On the other hand, Reid et al [21] in the review of 15 studies observed a non-significant reduction in participants with normal BP as compared to the significant reductions in the hypertensive participants. Houston [15] in his review of literature also observed a significant decrease in BP in the hypertensive groups.

There are evidences that suggest diverse ways by which cocoa could cause a decline in BP. Studies reveal that the hypotensive effect caused by dark chocolate could be as a result of the vasorelaxation ability of the flavanols. It is suggested that a specific flavanol called epicatechin causes the release of nitric oxide (NO) in the cells of the blood vessels. NO is believed to cause vasodilation of the blood vessels and this has been observed both in vitro and in vivo studies [27, 28, 31, 32]. Other studies have also suggested the ability of the flavanols to interrupt the renin angiotensin aldosterone system (RAAS) to produce the antihypertensive effect [27, 28, 32]. According to Egan et al. [28], another specific flavanol, procyanidins, has been observed to inhibit the activities of the angiotensin converting enzyme (ACE) which converts angiotensin I to the potent angiotensin II.

This section has analysed the reports on the BP reduction effect of dark chocolate/cocoa. Although there are other studies which reported that it has no effect on the BP, but in this literature review, it has been observed to have a declining effect on the blood pressure. However, cocoa cannot be given in place of orthodox antihypertensive medications but it could be used in combination with it. As a preventive measure, it could be beneficial to use as suggested mechanisms could help protect the normotensive from developing hypertension but caution should be taken as it could as well cause weight gain mitigating the desired effects.

**VITAMIN D**

Vitamin D has been observed to possess antihypertensive qualities. It is suggested that it is effective in attaining this when it is in its active form 1, 25(OH) (1, 25 dihydroxycholecalciferol) [14, 33, 34]. Some of its sources include oily fish, egg yolk, milk, margarines and the use of dietary supplements. But it is believed that vitamin D acquired from food intake is below 400IU/day and might not have significant effect on blood pressure [34]. The other means of acquiring vitamin D is exposure to ultraviolet B (UVB) light with wavelengths of 280-315nm (Ibid). It is believed that the level of plasma vitamin D (25-hydroxyvitamin D [25-OH D]) could be affected by several factors including age, race, how far away from the equator, the amount of skin exposed and the use of sunscreen [33, 34, 35].

Evidence has it that there is a relationship between level of plasma vitamin D and blood pressure. It is believed that blood pressure increases with decreasing levels of 25-OH D and vice versa [33, 36, 37]. The levels are in four folds: ideal [40ng/mL and above], adequate [30-39ng/mL], deficient [15-29ng/mL] and severely deficient [15ng/mL and below [33, 34, 36]. Forman et al [35] for instance, observed this correlation in their study in women and suggested that 25-OH D-deficient women were 47 % more at risk of having hypertension as compared to women with ideal levels of plasma vitamin D. High prevalence of 25-OH D deficiency has also been reported by several studies [33, 35, 36]. Forman et al. [35] report in their study that with a study population of 1484, 65.7% were had vitamin D deficiency.

However, results of studies into the ability of vitamin D supplementation to reduce blood pressure is equivocal. There are studies which observed a reduction in the blood pressure after supplementation [35] while others could find no changes in the blood pressure after supplementation with some studies rather observing an increase in blood pressure after the intervention [34]. The differences in findings however could be associated with several factors such as dose of vitamin D supplement and the duration, problems with the study designs and unmeasured factors that could have confounded these results [36, 38].

Forman et al [35] in their trial of 250 blacks observed a clinically significant range of reduction in the systolic blood pressure between 0.66 to 4.0 mm Hg, depending on the dose given to the various intervention groups. These results according to Geleijnse [34] and Vaidya and Forman [38] were not observed by other studies. In their various reviews, they report of other study findings that do not correlate the observations made by Forman et al. [37] but they do report of other findings of a meta-analysis which observed a non-significant reduction in both the systolic and the diastolic pressures.

Dose of 25 (OH) D supplement used in the various trials have been suggested to be one of the several reasons behind the different findings. Geleijnse [34] reports in her study that higher doses of vitamin D (1000 IU/day) could have a significant effect on the blood pressure. In their study, Forman et al [35] gave 1000, 2000 and 4000 IU/day to the intervention group for 90 days and observed a systolic reduction ranging from 0.66, 3.4 and 4.0 mm Hg respectively. Another study gave 40000 IU/week to the intervention group to observe the blood pressure reducing effect of vitamin D [34]. A counter argument is raised by Vaidya and Forman [38] who also report of a study which subjected the intervention groups to different doses of 40000, 20000 IU/week or placebo and observed no blood pressure lowering effect after a year.

Whereas blood pressure reducing effects of 25 (OH) D have not received a conclusive result, it is believed that it is more effective when it is used in combination with calcium to reduce blood pressure than using calcium alone. Evidence reveals that when it was used in combination with calcium, it reduced blood pressure by about 9.3% more than calcium alone [15, 33, 35]. In opposing view, Geleijnse [34] reports that there were no such observations in such similar combinations in another study. But it is observed that the dose used in the former study was more than the dose used in the latter. Vitamin D acquired from UVB have also been observed to have blood pressure reducing effect when it was used as an intervention in a study according to [34, 36]. This could be helpful as studies about dietary vitamin D supplementations have yielded ambiguous results and its dietary acquisition has been suggested to be not enough to effect changes.

25 (OH) D receptors have been noticed in to be widely spread in body tissues such as the vascular smooth muscle cells, juxtaglomerular cells among others [33, 35]. Plasma vitamin D has been observed to have effect on the renin angiotensin system (RAS), calcium-phosphorus homeostasis, and vascular mechanisms [35, 38]. Evidence has it that there is a correlation between 25 (OH) D levels and RAS activities in the blood and vascular cells. RAS activities have been observed to be high in low 25 (OH) D levels [38]. According to Forman et al [35], vitamin D could act as a negative RAS regulator restricting its activities. The RAS activities are restricted because 25 (OH) D prevents the renin expression thereby halting the system from even starting [33, 35]. Vitamin D has also been observed to inhibit hyperplasia and hypertrophy of vascular smooth muscle cells thereby improving endothelial dysfunction. This is achieved by enhancing the production of nitric oxide (NO) and preventing vascular smooth muscles contraction and enhancing vasodilation [33, 36, 38]. However, another school of thought argues that the effect on the vascular smooth muscle cells could be as a result of its ability to regulate calcium flux entry into the cells as calcium has also been identified to cause vasodilation [38].

In summary, the effect of 25 (OH) D on the blood pressure has been analysed and it has been observed to be unclear. But what this review has been able to establish is that most of the trials agree that lower plasma vitamin D levels are observed in hypertensive patients and the higher the 25 (OH) D level, the lower the risk of becoming hypertensive. Thus it would be safe to say that increasing plasma vitamin D levels through dietary supplements and to a lesser extent, dietary intake could prevent a normotensive person from hypertension.

**CONCLUSION**

Hypertension is a popular health menace affecting approximately a billion people in the world. It is believed to cause about 9.4 million deaths per year. As a result, it has become necessary to find ways to avoid it from affecting people as prevention is better than treatment. There are several studies that suggest numerous forms of preventive measures but this study focussed on how five foods could play a role in the prevention of hypertension. Studies assessing the role of reduced-salt diet, garlic, fish oil, chocolate and vitamin D were analysed. Five quantitative studies, representing each food, were critiqued for their integrity and their ability to change practice. The findings were then discussed in context of other evidence available from literature on how the selected food could prevent the development of hypertension.

Overall, it could be argued that these foods could prevent the occurrence of hypertension as per the literature reviewed by the author. Evidence from the study reveals that all of these foods had the ability to cause changes at the cellular level, especially in the vascular smooth muscle cells. However, other studies contradict these findings and report no attributable changes specific to these foods. However, this extended review of literature is not enough to comprehensively address how these foods could prevent the development of high blood pressure in people. Further

research into the abilities of these food items to prevent hypertension would be highly beneficial to the body of knowledge and the health care professionals.

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